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ELEMENTARY SCHOOL SCIENCE FAIR

materials

For parents, teachers, and others mounting a school science fair

drawing by Scout, via openclipart.org (public domain)

SO YOU WANT TO DO A SCIENCE FAIR IN YOUR ELEMENTARY SCHOOL? HERE'S SOME STUFF TO HELP

When my wife and I decided to volunteer as the organizers of the science fair at our son's elementary school, we knew we wanted to keep it simple and keep it true to what science really is. So here are some decisions we made that we hope you will consider:

- Understand your goal. For us, it was to ***give every interested student a firsthand experience with the scientific method***. Everything else followed from that goal.
- Make the fair noncompetitive. (see: the goal)
- Provide a small incentive (certificate, free pizza, etc) for everyone completing a project. (see: the goal)
- Discourage *demonstrations*, encourage science projects. (see: the goal. This packet explains the difference)
- Ask students to turn in a ***research plan*** before they can do their projects. This packet has easy examples. Have a 'Science Adviser' review the research plans and return them to students with practical and kind comments.
- Have a very simple structure for your volunteer group. We had one coordinator for all the organization and logistics, and one Science Adviser to review student research plans.
- We provided all students with a display board, so obtaining this would not be a barrier.

STUFF YOU SHOULD DO

- Leave enough time for the process to play out. You'll need a 2-3 months minimum to organize a science fair, coordinate with school staff, and let students plan and do their projects.
- If at all possible: find a parent who has worked as a scientist to be the Science Adviser, who reviews the proposals and returns them to kids with helpful, practical comments.
- Read and appreciate the attached packet. You are free to change it, but it's based on five years of experience running an elementary school fair, and it's written by a real scientist.
- Distribute the following packet -- with changes suited to your school -- to *every* student in your school. Things you will need to change are called out with XXXX's.
- Offer live volunteer help to students who want it.
- Enjoy the results

XXXXX (NAME OF SCHOOL)

ELEMENTARY SCHOOL SCIENCE FAIR

20XX

project planning packet

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WELCOME! HERE ARE THE BASICS.

- A SCIENCE FAIR is an event where kids show off science projects they have done themselves.
- ANY kid can do a science project. It does not need to be complicated or hard. This packet shows you how.
- You DON'T need a lab coat or goggles, even though they're stylish.
- You DO have to follow the all-important Schedule. (Below.)
- You WILL get a coupon for a free treat (probably a pizza slice) if you do a project.

Go through this packet with your parent, guardian, or other grown up helper. Come up with an idea and fill out the research plan (last sheet of this packet). If you need help, ask! The Science Fair committee will get someone to help.

THE SCHEDULE

- April XX, XXXX : deadline to turn in your research plan, but feel free to turn it in sooner. You will get personalized tips back from the Science Adviser within one week.
- Late April: do your project! Pick up your FREE display board from the school office.
- Early May: make your display board. (Instructions are in this packet.)
- May X: SCIENCE FAIR MORNING. **Bring your display to the gym before school begins** so it can be displayed all day.
- May X SCIENCE FAIR NIGHT EVENT. **Come to XXXX f**or XXXXX School Family Night and Science Fair. **Stand by your board during the designated hours (to be announced) to answer questions.** Get your certificate of achievement and coupon for a free treat!

FAQ

- *Can I do a project with a friend?* Yes! Solo, duo, group, and class projects are all fine.
- *Is the Science Fair competitive?* No! No one "wins" or "loses" our fair. Everyone who finishes a project gets a certificate of achievement and a coupon for a free treat.

FOR MORE INFORMATION CONTACT

- Jane XXXX Doe, Science Fair chair, xxxx@mail.com, (123) 456-7890
- http://aXXXXXXXwebsite.com -- web site with forms & late-breaking updates

AUTHOR'S NOTE (FOR PARENTS AND TEACHERS)

I'm a parent who has also been a working scientist. I've helped organize a K-5 school science fair for five years. I've found most science fair material available to the public at an elementary school level does not reflect how scientists really work. Real scientists don't spend much time demonstrating curious phenomena; rather they work to answer questions through formal observation and measurement. Though it is not always spectacular, in the end it is this process that engages the mind and produces discoveries. I wrote this packet for my child's school, where the goal of the Fair is to give every interested student a first-hand experience with the scientific method. Enjoy! -- Martin John Brown, spring 2016.

WHICH LEVEL ARE YOU?

Science isn't hard, but you probably don't have much practice at it yet. If you've never done Science Fair before, you should probably stick to Beginner level. If you have experience, you might want to challenge yourself with Intermediate. Advanced level is only for die hards.

Every level qualifies you for a treat. Everyone who finishes a project is a winner.

BEGINNER LEVEL: what science really is

You might think that to do science, you need giant laboratories, blinking computers, or fancy telescopes.

Those things are cool, but they're not science. They're just tools (or toys!) that some scientists use. A scientist's main tools are their own eyes, ears, and brain.

Science is really just a way of learning. At the beginner level, there are only two steps to doing your own science project:

- *Ask a question*
- *Try to answer your question using measurements you make yourself.*

Here is a science fair research plan by Kaylee, who is in first grade. See how she has a question, and a thing she can measure to answer it. She can even imagine what her final chart will look like.

Kaylee's research plan

WHAT is the QUESTION your project is going to (try to) answer?

How many of each color come in a big bag of Skittles?

WHY are you interested in this QUESTION?

I really like Skittles but I like the green ones most.

What MEASUREMENTS will you make to answer your QUESTION?

My measurement will be counting. I will count the number of each color of Skittle in a big bag of Skittles.

Sketch out a GRAPH or CHART that shows how your MEASUREMENTS might answer your QUESTION.

I will show my results in a pie chart like this. Right now I am just guessing at the numbers but after I do my experiment I will put in what I find out.

Your question can be about nearly any subject. However, it helps if the subject is something that really matters to you. That's what Isaiah did on his research plan for the science fair. Isaiah is in the third grade.

Isaiah's research plan

WHAT is the QUESTION your project is going to (try to) answer?

What kind of ball bounces highest, rubber, paper, or wood?

WHY are you interested in this QUESTION?

My brother and I have ball-bouncing contests and I want to win.

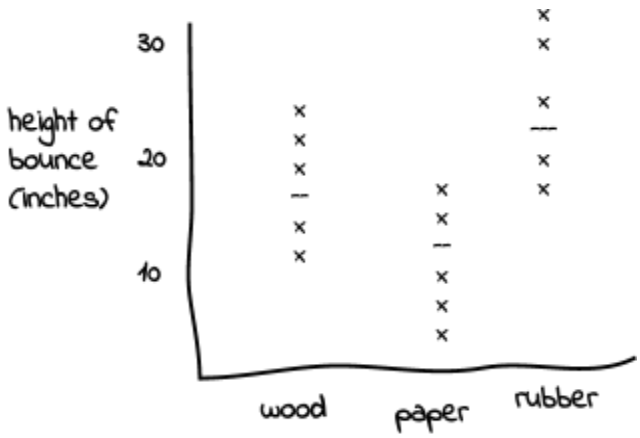
What MEASUREMENTS will you make to answer your QUESTION?

My measurement will be seeing how high the ball goes. My dad will drop each ball from the same height and I will see how high it goes with a yardstick taped to the wall.

Sketch out a GRAPH or CHART that shows how your MEASUREMENTS might answer your QUESTION.

I will show each bounce with an X on a dot chart like this. My mom will help me figure out the average (--).

These numbers are guesses but I will put the real ones in after we do the test!



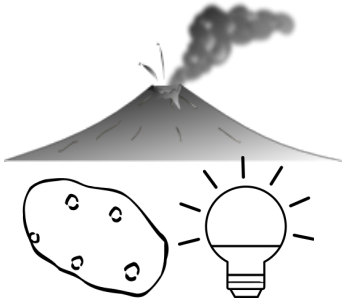
CAN YOU GIVE ME SOME MORE IDEAS?

Absolutely. Remember your project can be about anything you like -- animals, plants, human behavior, the weather, you name it, as long as you are *answering a question with measurements*. Here are some actual kid projects from previous science fairs:

Subject area	Kid question	Thing(s) measured
Ecology/agriculture	How many worms are in my backyard?	Worms per square foot, size of yard
Sports medicine	Which exercise makes my heart beat faster, biking or running?	Heart rate*
Nutrition?	What liquid dissolves Peeps candy ducks the fastest?	Time to dissolve
Nutrition?	What brand of gum blows the biggest bubbles?	Bubble volume
Materials	What makes rubber brands more breakable, heat or cold?	Length at breakage*
Human behavior	How many numbers can people remember?	Length of number remembered
Engineering	What paper airplane design flies the farthest?	Length of flight
Entomology	Do ants prefer sugar or artificial sweetener?	Time ants spent with each substance
Fire ecology	What are the safest trees to plant near your house, in places that have lots of forest fires?	Amount of water required to extinguish burning branch*

** Adult supervision clearly required for a project like this.*

WHERE CAN I GET EVEN MORE IDEAS?
WHAT ABOUT BAKING SODA VOLCANOES AND POTATO BATTERIES?



There are dozens of pages on the Internet that have science fair project ideas. Currently the best one is http://sciencebuddies.org. *Many* projects at the *beginner* level of ScienceBuddies.org will work for elementary school students.

Beware of projects that put on a show, but don't ask a question or answer it with measurements. For example, a site might suggest making a model volcano that "erupts" when you mix baking soda and vinegar, or lighting up a bulb with electricity from a potato battery.

Those aren't science fair projects--*yet*. To make them into science fair projects, change them so you are *answering questions with measurements*. For example:

- What brand of baking soda makes my baking soda volcano erupt the highest? (You measure the height.)
- What keeps a bulb lit longer, a store-bought battery or a potato battery? (You measure the time.)

If you are having trouble turning your demonstration into a question, contact the Science Fair committee, they are there to help!

INTERMEDIATE LEVEL:
QUESTIONS THAT MATTER, FAIR TESTS, AND PREDICTIONS

Perhaps you're old enough to feel like you can go beyond the basics. That's what Nate -- who is in fourth grade -- is going to do. At first, his project sounds a lot like Isaiah's. He's going to measure how far something flies.

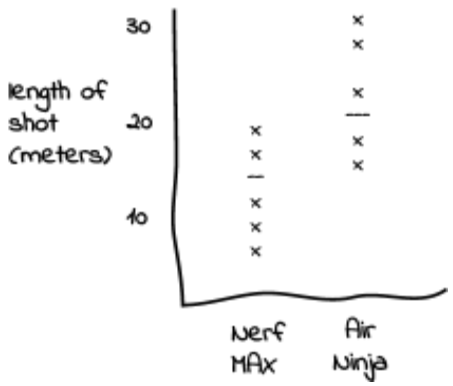
Nate's research plan (first page)

WHAT is the QUESTION your project is going to (try to) answer?
Which brand of foam dart gun shoots the farthest, NERF MAX or AIR NINJA?

WHY are you interested in this QUESTION?
I like being in foam gun wars with my friends and want to win.

What MEASUREMENTS will you make to answer your QUESTION?
I will shoot each kind of gun and measure how far each shot goes.

Sketch out a GRAPH or CHART that shows how your MEASUREMENTS might answer your QUESTION.
I will make a graph showing all the shots (x's) and the AVERAGE (-) for each brand, like this:



But because Nate wants to move up to Intermediate level, he has to answer some extra questions on the research plan.

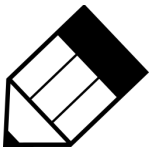
Nate's research plan (second page)
Why is your QUESTION important to other people, or the world? Lots of kids like to play with foam dart guns. And there are lots of TV ads for them.
How have other people answered your QUESTION? The TV ads for AIR NINJA say their foam darts go twice as far as NERF MAX. But my friends have said that NERF MAX is better.
What are you going to do to make your test truly FAIR? I will set up a fifty m measuring tape and shoot both AIR NINJA and NERF MAX foam dart guns, measuring the length of each shot. I will make 10 shots per brand, holding the gun at the same angle each time. I will compare the average lengths for each brand.
What do you predict the result will be? (In other words, what is your HYPOTHESIS?) I predict that the ads are true and Air Ninja will go twice as far as Nerf, on average. That's because I believe TV ads are always true.

The Intermediate questions are the kind of details that grown-up scientists work hard to get right. Grown-up scientists:

Try to work on questions that matter -- that are important somehow, to someone. Nate has to explain why his question about foam dart guns is worth working on. He says that it's to test if the TV ad is right, or his friends are right.

Know the background of their subjects. Nate needs to know how *other* people have answered the question he is working on. Studying other people's work, and seeing the good and bad things that can be in it, is an important way scientists make their own projects better. Nate knows what his friends say and what the TV ads say -- that's good enough for Intermediate level.

Work to make their tests as FAIR as possible. That means they don't arrange things so that one answer will win. If Nate wanted Nerf Max to lose, he could aim the gun at the ground every time he shot that brand. But he is going to be fair and use the same angle every time.



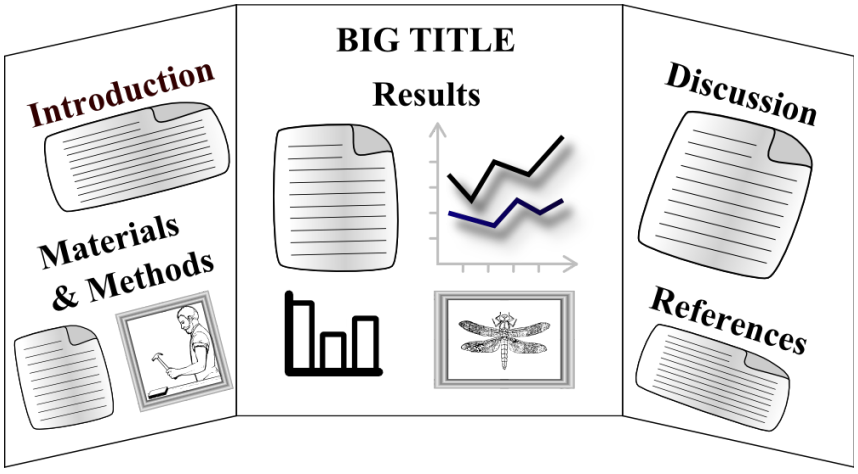
Write down a prediction of what the outcome will be, and explain why. It's a funny idea, making a prediction *before* you do your test -- but it's key to being a good scientist. Making and explaining a *hypothesis* (that's the fancy word for prediction) forces you to explain how you think things work. In this case Nate explains that he always believes advertisements. Do you think he should?

THE DISPLAY BOARD

The artistic part of doing a science fair project is creating a tri-fold display board to show your work.

This board is the MAIN way people will learn about your work! Everything that matters about your project should be on the board. **Don't plan on performing any experiments "live" during the fair. Don't bring messy, smelly or dangerous stuff to the fair. Don't bring any animals.** Instead, take pictures of your tests and subjects and add them to the board. *If you want to bring a few relatively neat things that will go well with your board, they should fit into one shoebox with your name on it.*

Make your display board nice, but keep it simple. *Real* scientific reports usually have only a few sections of substance:



- The **TITLE** should be catchy and accurate. For example: *FOAM GUN WAR! Which shoots farther, Ninja or MAX?*
- The **INTRODUCTION**: State your general subject and why you are interested in it. End on your project's **QUESTION**. For example: *I really like shooting foam darts, but I've always wondered if the advertisements on TV were true. I asked: can Air Ninja really shoot twice as far as Nerf Max?*
- **MATERIALS & METHODS:** Explain exactly how you studied the question — all the information someone else would need to redo your experiment. For example: *I bought new Air Ninja and Nerf Max sets, and set up a shooting range on the playground with a 25 meter measuring tape. I shot each gun 10 times at a 45 degree angle and recorded each distance.*
- **RESULTS**: Report, in words, pictures, and charts, the results of your work. For example: *Air Ninja shot an average of 17 meters, with a range of 10-24, while Nerf Max shot an average of 19 meters, with a range of 18-20. Nerf Max performed better on average, and was more consistent, but Air Ninja had the longest single shot.*
- **DISCUSSION**: Talk freely about what influenced your results and how your discoveries might be relevant to readers. Say what further research should be done now. For example: *Air Ninja's claim to shoot twice as far as Nerf Max is not true. (I cannot believe someone lied in a TV ad!) But once in a while Air Ninja had a very long shot. If the reliability of Air Ninja could be improved, it could be the best foam gun. Further research on Air Ninja's long shots would be interesting.*
- **REFERENCES**: Write the list of books, web sites, etc, that you used as background. Give detail so someone else could find them. For example: *1) Youtube video ad, http://youtube.com/blahblah.html, accessed 5/25/13. 2) John Smith, "Effect of dart shape on performance," Journal of Foam Gun Studies, volume 24, page 13.*

TIP FROM A REAL SCIENTIST: Don't try to sound super technical. The idea is to be *clear* about what you did and what you think it means.

ADVANCED LEVEL:
THE SCIENTIFIC METHOD AND FINER POINTS THEREOF

This section is only for those crazy enough to go to the Advanced level. Warning -- if you do want to go Advanced, you'll have to get philosophical. You have to think beyond your research question to (drum roll please!) the nature of learning itself.

Consider the good old scientific method. At the Beginner and Intermediate levels, we were practicing it, but we didn't name the steps. For Advanced, let's spell them out.

You start by ASKING A QUESTION. It just has to be a question you can answer with some kind of measurement, and often it should *matter* to other people or the world.

Next you do BACKGROUND RESEARCH, which means finding out what other people say about the topic and your question. For Beginners and Intermediates, a few sources are fine. For Advanced...

Better background research comes from credible sources -- things written by scientists or other people who have worked directly in the subject area. If your question is about how far girls can broad-jump, a track and field coach is a credible source, but a debate coach isn't.

Now you CONSTRUCT A HYPOTHESIS. This statement contains your best guess about what the final results will be, for example "girls can broad jump between 1 and 2 meters." That's a good hypothesis because it's *dis*provable. Sounds weird, but for a project to be scientific, it *must be possible* the test will prove the hypothesis is wrong! For example, the broad-jump hypothesis is disproved if girls jump 3-4 meters.

The best hypotheses go beyond disprovable. They are also NOT BORING. That means you really don't know what will happen. For example, "girls can broad jump 100-200 meters" is disprovable, but boring, because you already are pretty sure people can't jump that far. Advanced projects have interesting hypotheses that really could go either way.

Now you TEST WITH MEASUREMENTS. But some measurements are better than others.

Better measurements are reproducible. That means other scientists should be able to copy your work. For example, you could measure the length girls can broad-jump using cracks in the sidewalk, or a yardstick. Both are measurements, but only the yardstick version is reproducible -- because other scientists don't have the same sidewalk!

Next, ANALYZE RESULTS AND DRAW CONCLUSIONS. Nearly all science projects will consider how their results compare to their hypothesis: is the hypothesis true, false, or partly false? But..

Better analyses go beyond simple yes/no answers. For example, they don't just look at averages, they also look at variation. For example, "My hypothesis was right -- girls did jump further than boys, with averages of 2.4 vs. 1.8 meters. But boys had a much bigger range of jumps, 0.4-3.8. That might be because..." In high school or college, formal statistical tests may use the variation.

Next, PUBLISH RESULTS in a report or a display board, so other scientists can know about your work.

The very last step is THINKING AGAIN. That's because in real science, a lot of hypotheses turn out to be false or only partly true. The vision of reality that led to your project's hypothesis was a little bit wrong.

Better scientists aren't disappointed if their hypotheses fail. They use their "failures" as fuel for creating new and better questions and hypotheses. That's how science progresses. Ideas get proved wrong, and slightly less wrong ideas take their place. No one said it was pretty, but it works, and it's kind of addicting once you get into it. :)

XXXXX ELEMENTARY SCHOOL SCIENCE FAIR research plan 2xxx

Student Name and Date:	Teacher and Grade:
Parent or Guardian Name, Phone Number, and email:	
Is your project a collaboration with other kids? If so, please list your partners:	
Which grown-ups are going to help you? Name at least one.	
WHAT is the QUESTION your project is going to (try to) answer?	Sketch out a GRAPH or CHART that shows how your measurements might answer your question. You won't know the final answers yet but you can still guess.
WHY are you INTERESTED in this QUESTION?	
What MEASUREMENTS will you make to answer your QUESTION?	
I have read the following RULES for the Science Fair, and agree to follow them. ● My project will not involve explosives or anything that would break school rules or laws. ● My project will be safe for people and animals. I can *observe* people or animals, but not *bother* them or *hurt* them. I will not bring animals to school. ● An adult will supervise me during any use of tools, electricity, chemicals or other hazards. ● My parents can help, but I'm the scientist and it's my project.	
Signature of student	Signature of parent/guardian, with date

Beginner level: you are done with the research plan! Turn it in and you will get comments back soon.
Intermediate or Advanced levels: fill out the other side too, then turn it in.

ADDITIONAL QUESTIONS FOR INTERMEDIATE AND ADVANCED PROJECTS

Why is your QUESTION important to other people, or the world?
How have other people answered your QUESTION? (What are your sources of background info?)
What are you going to do to make your test truly FAIR?
What do you predict the result will be? (In other words, what is your HYPOTHESIS?)

EVEN MORE QUESTIONS, FOR ADVANCED PROJECTS ONLY

Read the page about Advanced projects, and explain one or more ways that your project is Advanced. For example: ● In what way are your background research sources credible? ● Could your hypothesis be *dis*proved? How? And if so, in what ways is it *not boring*? ● In what way are your measurements reproducible? ● Do you anticipate there will be variation in your results? What do you imagine it might mean? ● If your hypothesis is disproved, how will your view of the world change? (Add pages if nec. :))